An ontology for Systems Engineering based on ISO 15926-11

Semantic encoding of Systems Engineering information

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- **Chairman Dutch standards committee Automation systems and integration**
- **Member ISO TC 184/SC4 Industrial data (i.e. ISO 10303 STEP, ISO 15926)**
- **Member INCOSE Netherlands, SIG infrastructure**

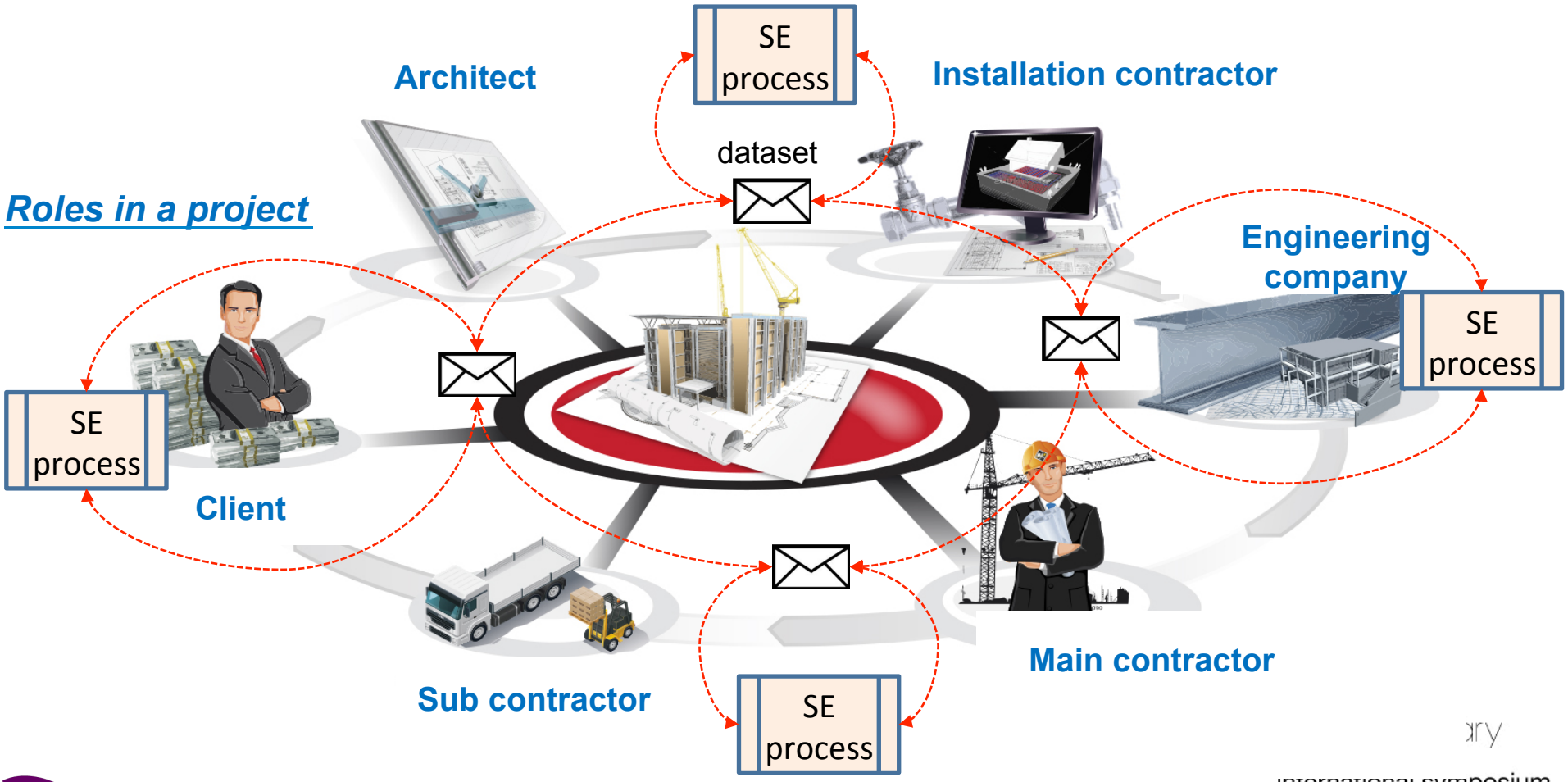
25th anniversary annual INCOSE international symposium
Seattle, WA
July 13 - 16, 2015

Agenda

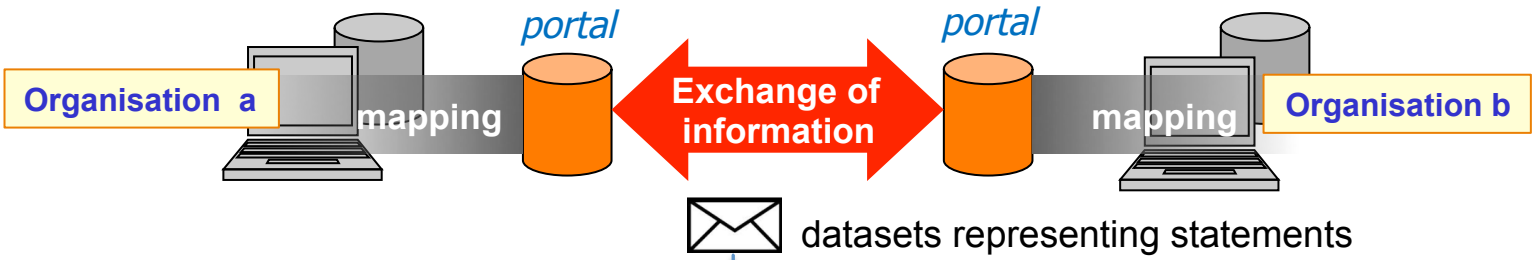
- Interoperability issue in Systems Engineering projects.
- Principles of semantic encoding of information according to ISO 15926-11.
- Creating an ontology for SE applying these principles.
- A sample of a resulting taxonomy and set of relationships.

Actual issue concerning interoperability in projects delivering complex systems:

"How to create and exchange information so that each role can do its (SE) tasks effectively"



Distinguishing layers with respect to information exchange (ISO 15926 and ISO 8000)



Information quality

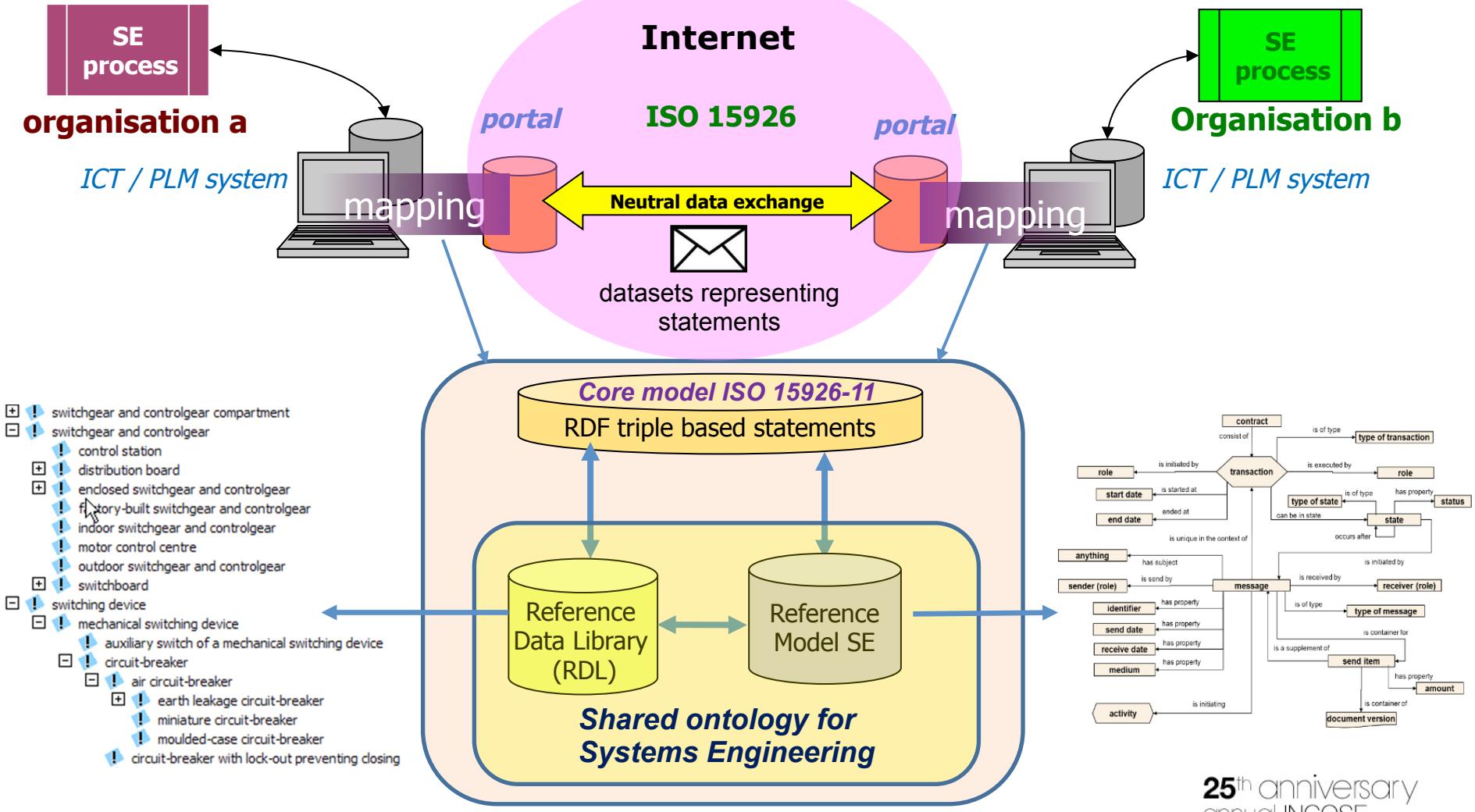
Contextual data quality

Enterprise role	Organisations, transactions, roles
Scope/Domain	Domain specific reference models
Content	Terms and definitions, reference data (RDL)

Core data quality

Semantics	Encoded statements with meaning
Syntax	Data format and structure of statements
Storage	Format and structure of a dataset

Data-exchange of engineering data based on ISO 15926-11



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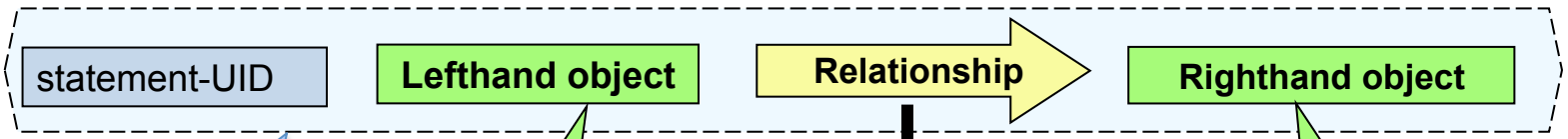
Principle of semantic encoding of engineering information within ISO 15926-11

1	Deck crane B7	is classified as	RDL:Pedestal Crane
2	Deck crane B7	has property	Total weight deck crane B7
3	Total weight deck crane B7	is classified as	RDL:Total Weight
4	Total weight deck crane B7	has magnitude	"400"
5	Total weight deck crane B7	is quantified in	RDL:Tonnes



Origins from ISO 10303 AP221 and STEPlib

statement

- RDL item,
- instance of a RDL item

- is a part of
- is quantified in
- is described by
- has property
- is initiated by
- is involved in
- is location of
- has magnitude
- is objective of
- .... etc.

- RDL item,
- instance of a RDL item,
- value

Examples of standardized relationships by ISO 15926-11

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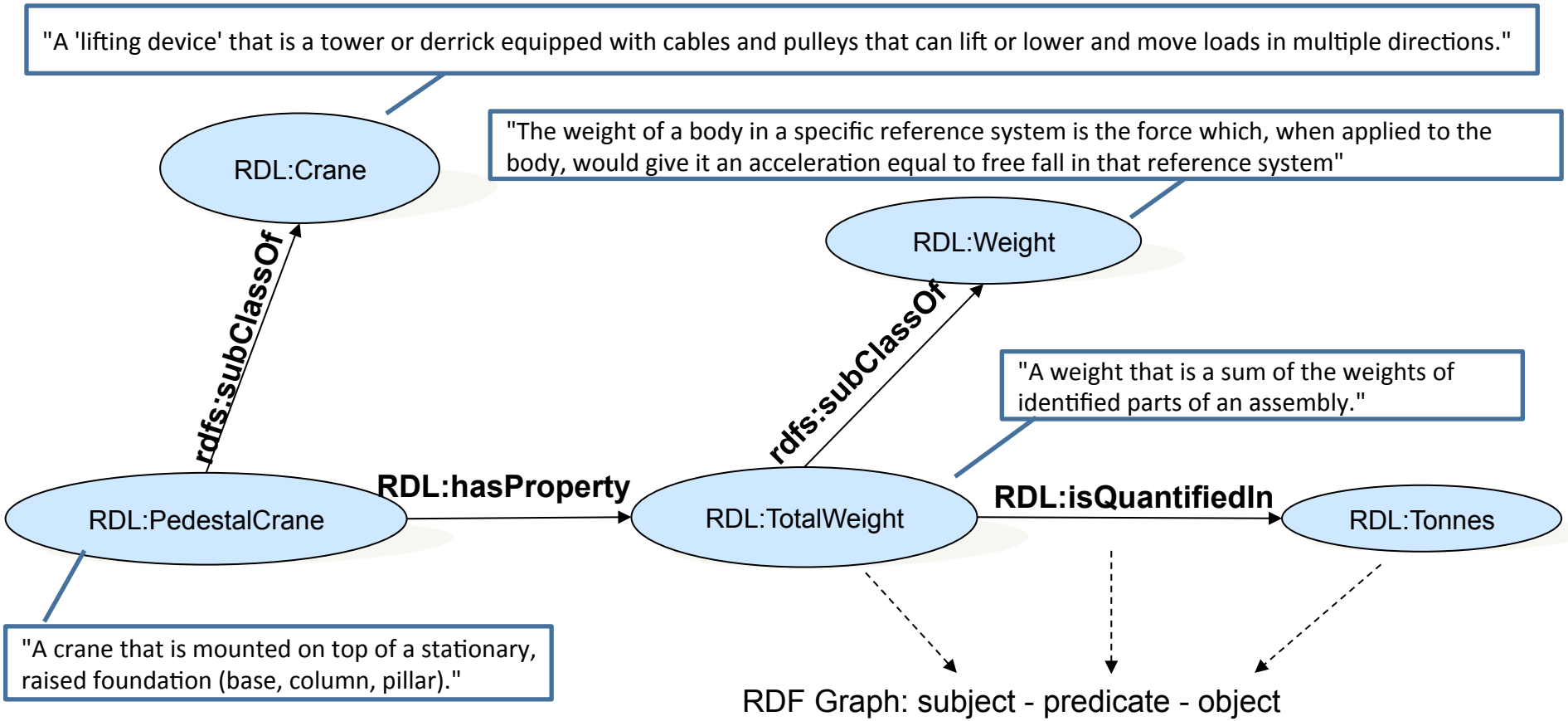
Use of industrial Reference Data on class level based on RDF



Subject: Lefthand object
Predicate: Relationship
Object: Righthand object

Triple based statements using the Resource Description Framework (RDF) from W3C

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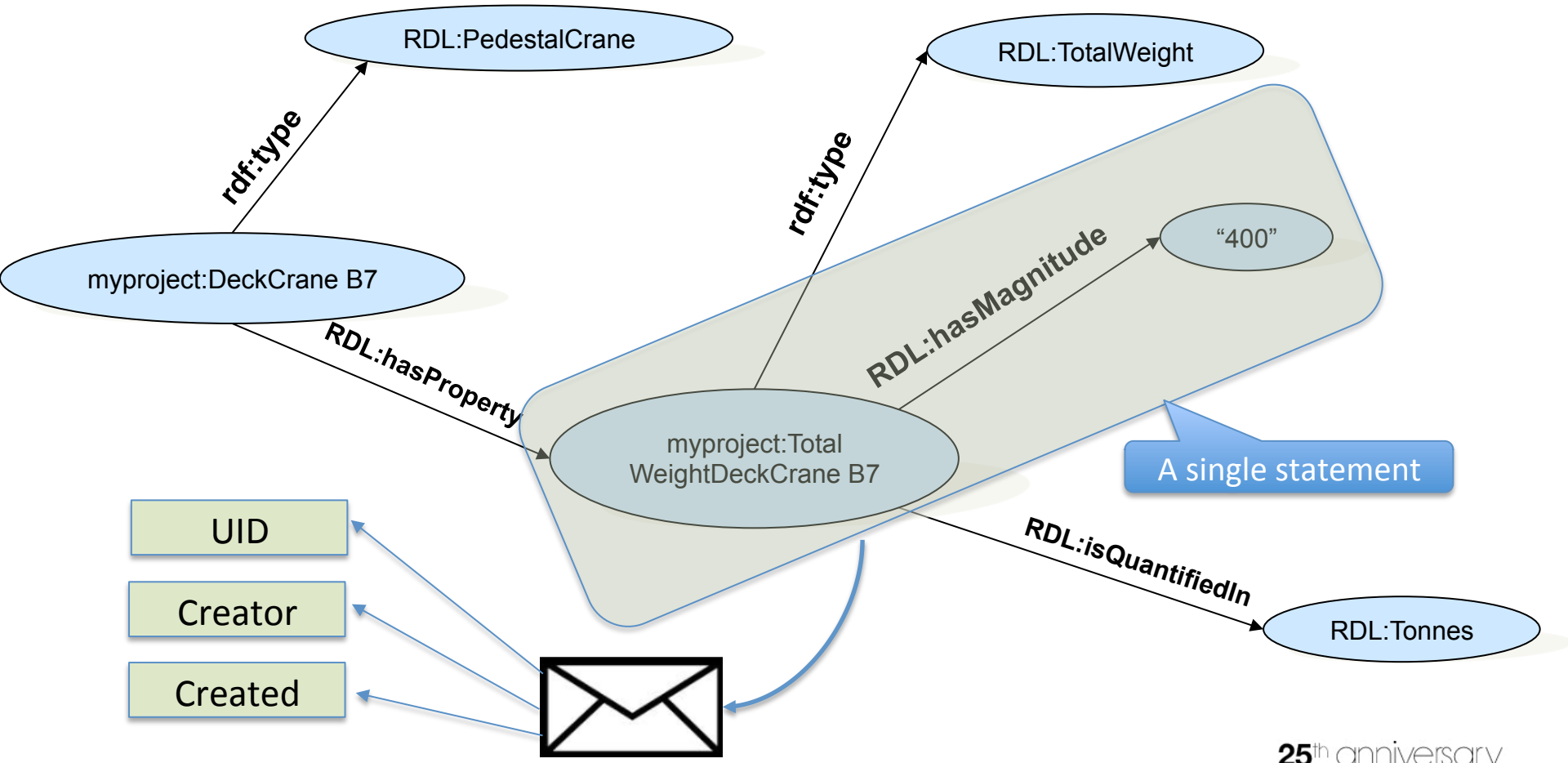
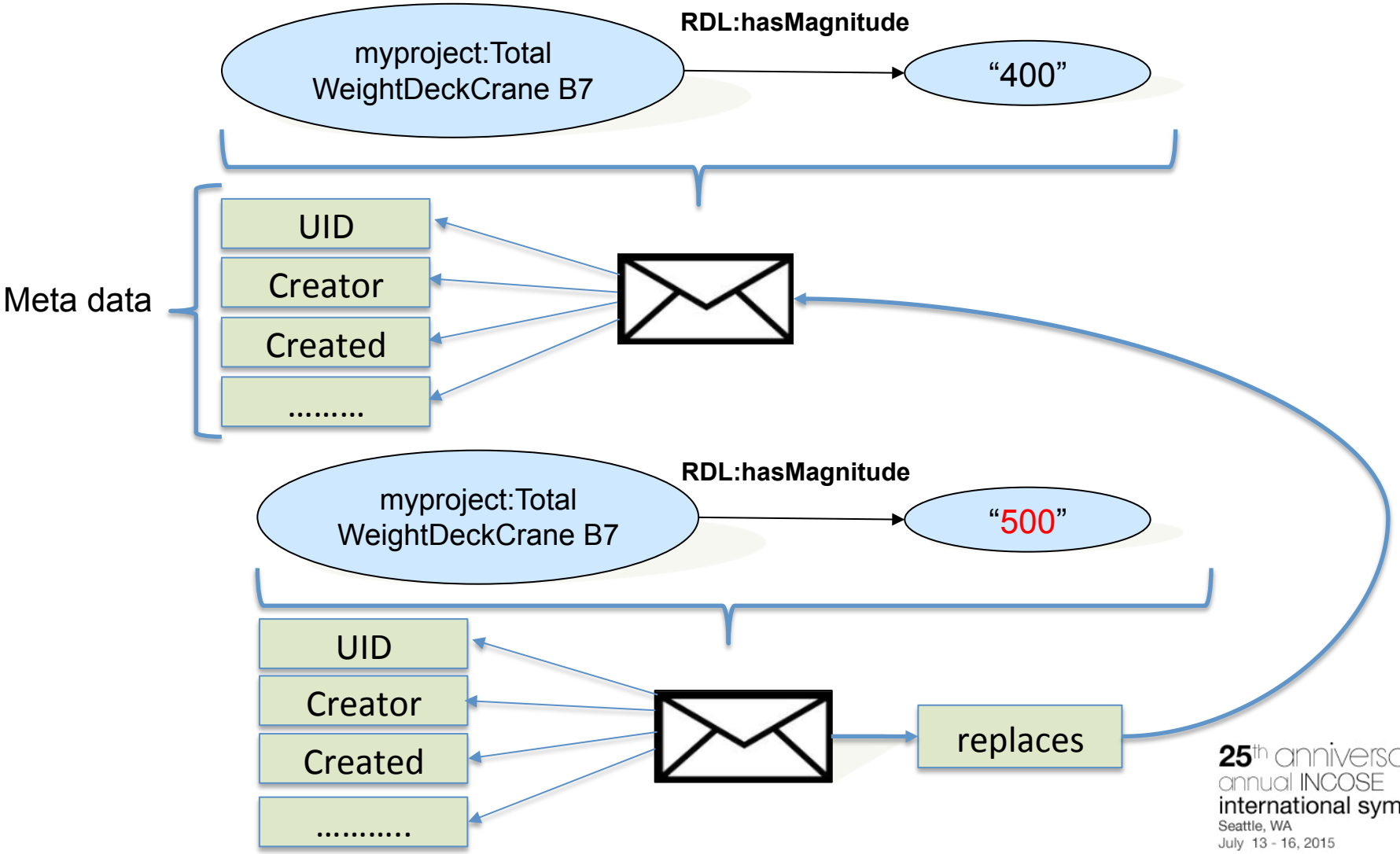
Sample of concrete project data, semantically encoded by Reference Data



Dataset representing a single statement
(can be seen as a Configuration Item)

Configuration management of a dataset as a CI

(A "RDF Named Graph" as defined in ISO 15926-11)



Applying the semantic encoding principle on process descriptions taken from ISO 15288: System Life Cycle Processes (1)

ISO 15288-2008 5.1.2 Systems:

A system can be viewed in isolation as an entity, i.e., a product, or as a collection of functions capable of interacting with its surrounding environment.

Humans can be viewed as both users external to a system and as system within a system;

ISO 15288-2008 6.4.1 Stakeholder Requirements Definition Process:

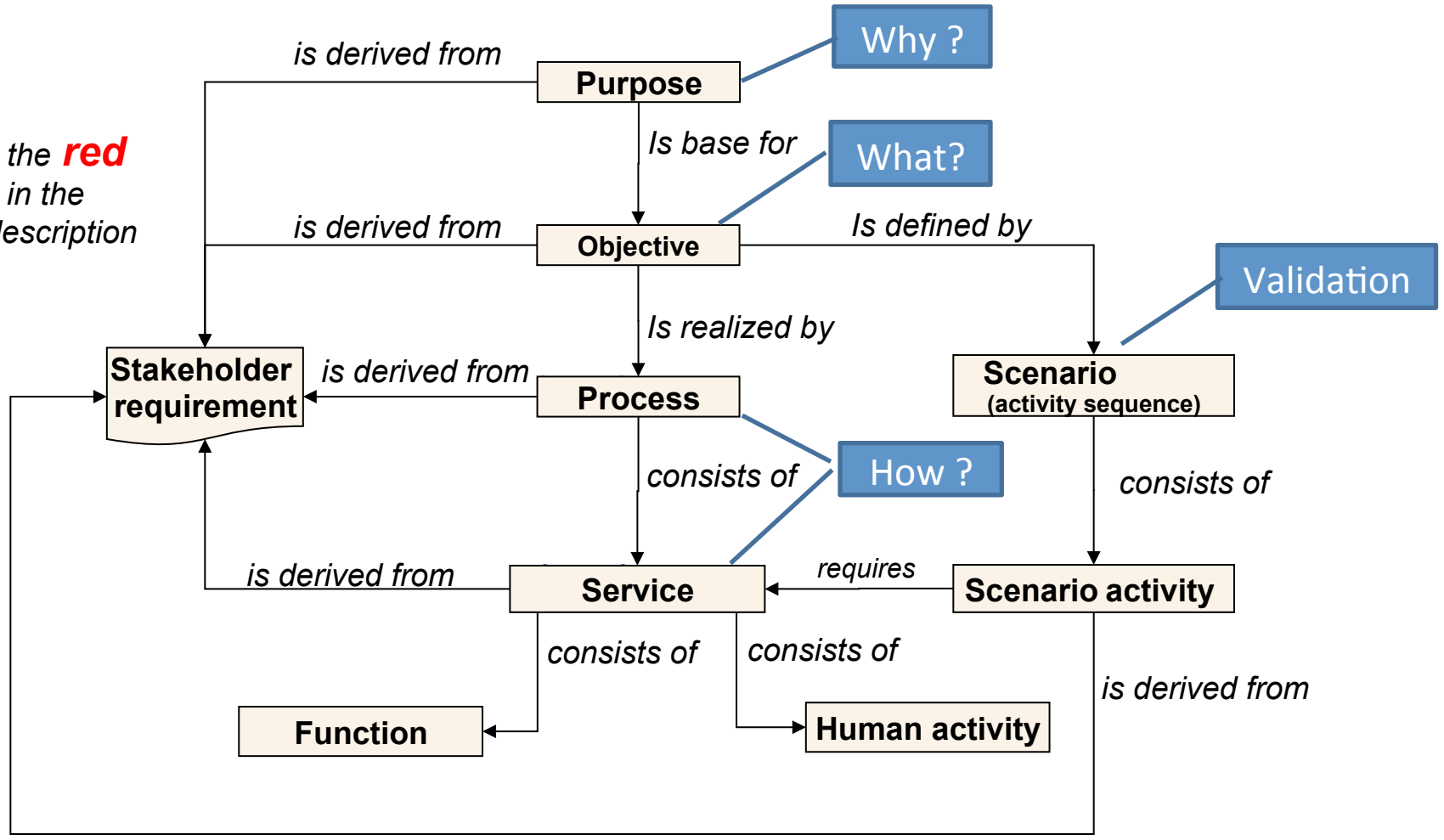
Stakeholder requirements are expressed in terms of a model that may be textual or formal, that concentrates on system purpose and behavior

Include in the context analysis the activities that users perform to achieve system objectives

Define a representative set of activity sequences to identify all required services that correspond to anticipated operational and support scenarios and environments

Semantic encoding of ISO 15288 "Stakeholder requirement definition process"

*Based on the **red** keywords in the process description*



Applying the semantic encoding principle on process descriptions taken from ISO 15288: System Life Cycle Processes (2)

ISO 15288-2008 6.4.2 Requirements Analysis Process:

Transform the stakeholder requirement-driven view of desired services into a technical view of a required product that could deliver those services

Build a representation of a future system that will meet stakeholder requirements and that does not imply any specific implementation. It results in measurable system requirements.

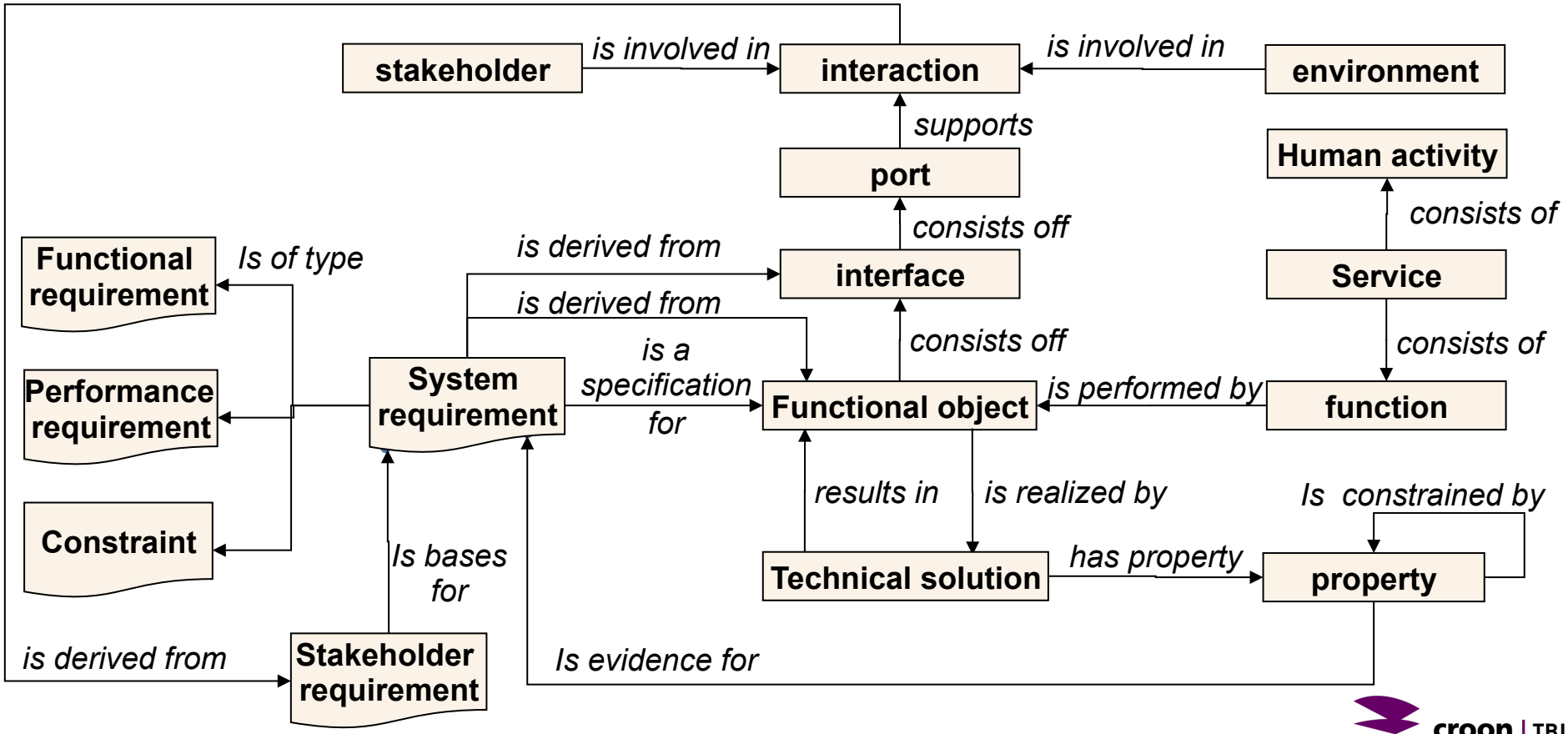
Define the required interactions between the system and its operational environment in terms of interface constraints

Define each function that the system is required to perform.

The required characteristics, attributes, and functional and performance requirements for a product solution are specified

Semantic encoding of ISO 15288 "Requirement analysis process"

(also representative for the architectural design)



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Applying the semantic encoding principle on process descriptions taken from ISO 15288: System Life Cycle Processes (3)

ISO 15288-2008 6.4.9 Operation Process and 6.4.10 Maintenance Process:

Services that meet stakeholder requirements are delivered.

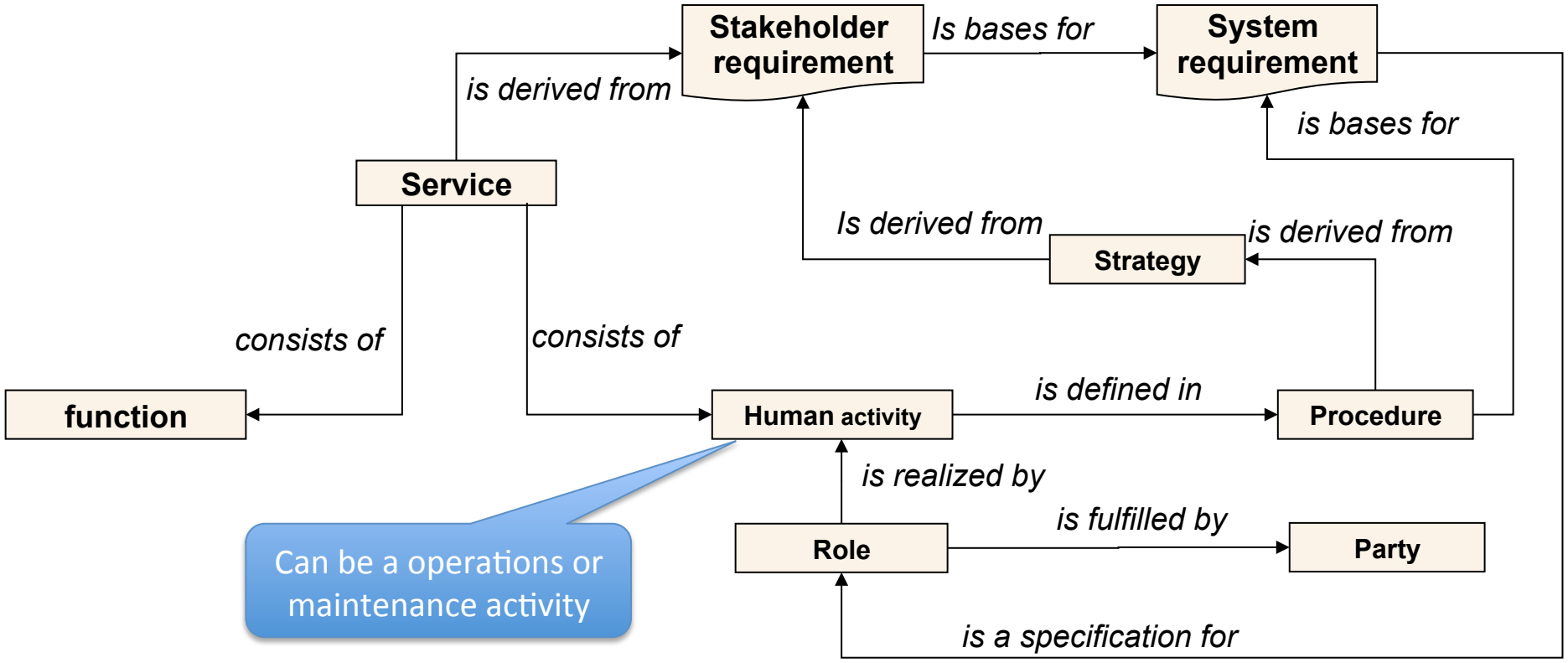
Services meeting stakeholder requirements are sustained.

Operator knowledge, skill and experience requirements guide the personnel selection criteria

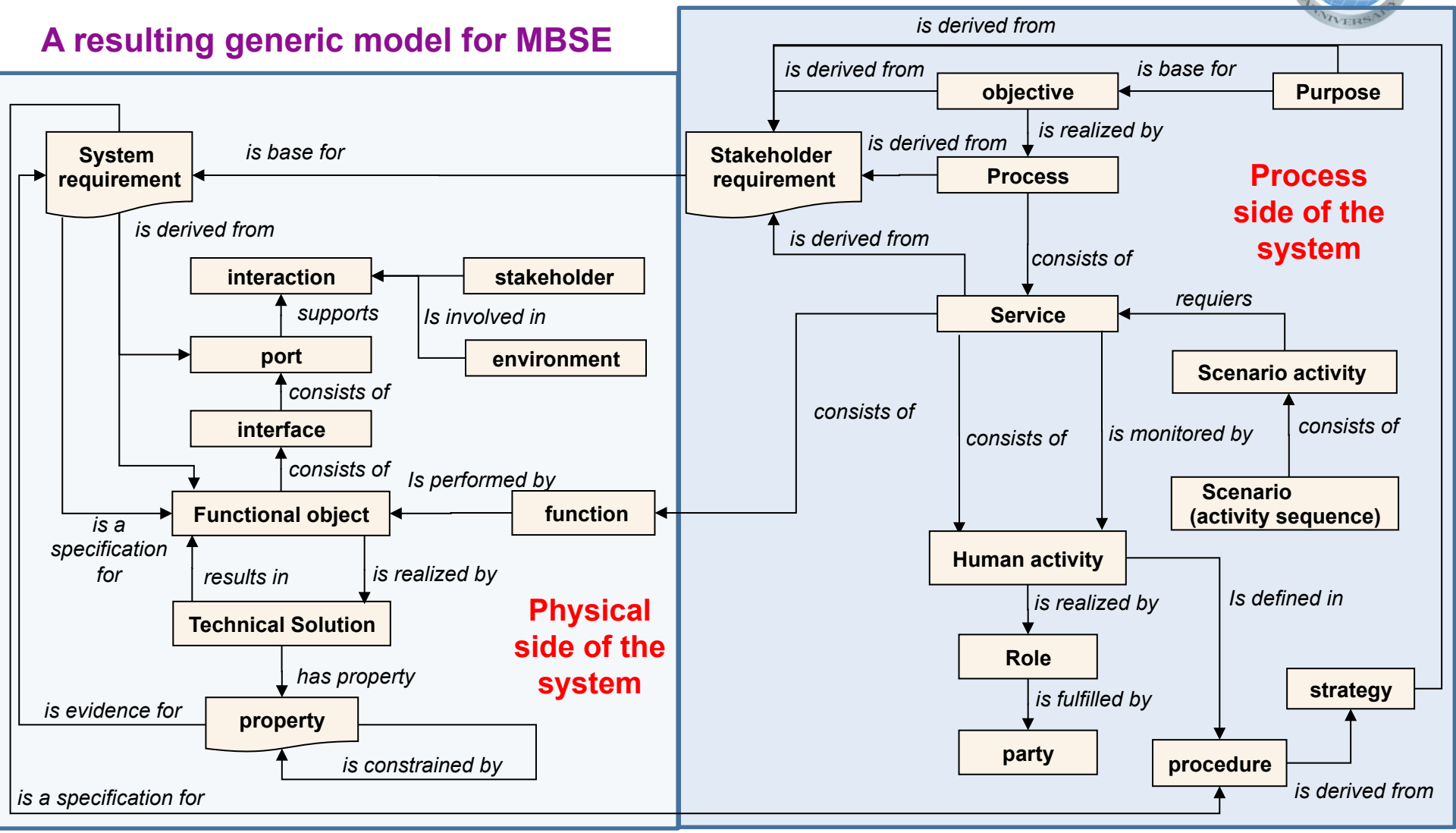
Maintenance constraints are provided as inputs to requirements

Define the constraints on system requirements that are unavoidable consequences of the maintenance strategy.

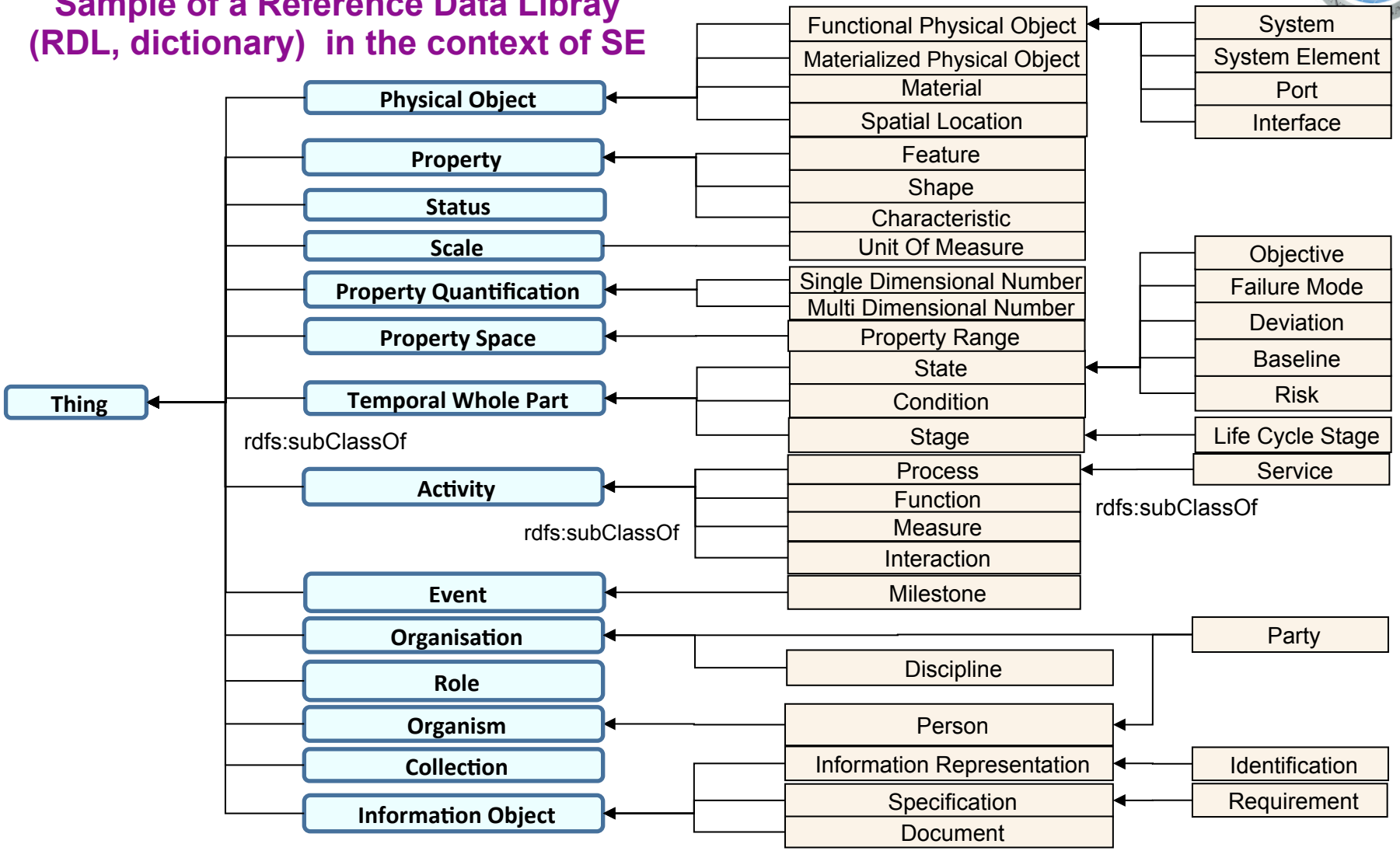
Semantic encoding of ISO 15288 "Operation and maintenance process"



A resulting generic model for MBSE



Sample of a Reference Data Libray (RDL, dictionary) in the context of SE



Fragment of the initial set of SE relationships used in the ontology

Part 11 relation class name	Reverse name	Definition	Domain	Range
complies with	defines compliance criteria for	a specialization where the subject shall be conformant to the specification of the object.	thing	information object

Findings and conclusions

A semantic approach fits well with the richness and dynamics of Systems Engineering information.

A initial ontology for SE needs approx. 300 different concepts and 150 different kind of relationships.

The presented ontology has been successfully applied in complex infra structure projects.

There is a gap in the availability of software tools that can supports ontology based SE.

Usage of the ISO 15926-11 RDF Named Graph approach leads to effective data-integration solutions, improving interoperability and allowing configuration management even on statement level.

Experiences have shown that the topic of ontology is important for systems engineering and that there is merit in further examining the suitability of ISO 15288 as an ontological foundation, enabling formalized MBSE

Questions ?

What to do

How to define

ISO 15288
System Life Cycle Processes

ISO 15926
Life Cycle Data Integration

ISO 8000
Data quality

Systems Engineering

Ontology and data-exchange enabling MBSE